

## **Method and System for Verifying Originality of Data**

### **CROSS-REFERENCE TO RELATED APPLICATIONS**

5        This application is a continuing application, filed under 35 U.S.C. section 111(a), of International Application PCT/JP01/05525, filed June 27, 2001.

### **TECHNICAL FIELD OF THE INVENTION**

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      The present invention relates to data communication technology, more particularly to technology for verifying originality of data.

### **BACKGROUND OF THE INVENTION**

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      In E-commerce, in order to avoid alteration in document data such as a contract for a transaction, a predefined hash algorithm is applied to the document data to generate a hash value. The digital signature is also decrypted to restore a hash value, and the restored 20 hash value is compared with the generated hash value to verify whether there is no alteration. Such technology can process transactions between two parties without problems.

      However, in international trading, many companies and various administrative agencies are involved in one transaction. When 25 communication is carried out between only two parties of such companies and administrative agencies, the aforementioned technology may be sufficient. However, if three or more parties of the companies and/or administrative agencies are involved in the communication of the document data, the aforementioned technology is not always 30 applicable. For example, when document data is sent from A to C via B, the document data generated by A may not be processed by C because the original format does not conform to a system or regulation of C.

In this case, B may convert the format of the document data to conform to the system and/or the regulation of C. However, such format conversion invalidates the verification of A as a transmission source.

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#### SUMMARY OF THE INVENTION

Therefore, an object of the invention is to provide technology for providing the verification of a transmission source even if the 10 original document data is changed on the way.

In order to achieve the aforementioned object, an information processing method performed by, for example, a RSP (Repository Service Provider) server according to a first aspect of the invention includes the steps of: receiving first data (e.g., document data such 15 as an invoice) and a first digital signature for at least the first data from a first computer (e.g., a TC (Trade Chain) server); performing format conversion corresponding to a destination (including, for example, not only the direct destination but also destination country) of the first data, for the first data received 20 in the receiving step to generate a second data; and sending at least the second data generated in the step of performing format conversion, a format reverse-conversion program for performing reverse conversion of the format conversion, and the first digital signature to a second computer (e.g., a TC server of the destination) associated 25 with the destination.

Thus, by sending the format reverse-conversion program and the first digital signature for the first data before the format conversion, it becomes possible for the second computer to verify whether there is no alteration in the first data. That is, it becomes 30 possible to obtain the verification of the first computer or its administrator or manager as the transmission source.

Incidentally, in the aforementioned receiving step, a third

digital signature for at least the format reverse-conversion program may be received. That is, the first computer may guarantee the format reverse-conversion program to the destination. Further, the format reverse-conversion program may be further received in the receiving 5 step.

The information processing method according to the first aspect of the invention may further include the steps of: receiving a request for sending a format reverse-conversion program, including designation of the destination from the first computer; extracting 10 the format reverse-conversion program corresponding to the destination from a format reverse-conversion program storage, and sending it to the first computer. A digital signature for the format reverse-conversion program sent in response to the request may be generated in the first computer.

15 An information processing method performed by, for example, a RSP server according to a second aspect of the invention, includes the steps of: receiving first data and a first digital signature for at least the first data from a first computer; performing format conversion corresponding to a destination of the first data, for the 20 first data received in the receiving step to generate a second data; and sending at least the second data generated in the step of performing format conversion, identification information (for example, a format reverse-conversion program ID, or information on the transmission source if the format reverse-conversion program can 25 be specified by information on the first computer as a transmission source) to identify a format reverse-conversion program for performing the format reverse-conversion, and the first digital signature to a second computer associated with the destination.

For example, if the format reverse-conversion program is kept 30 in the second computer, the second computer can perform format reverse-conversion for the second data to restore the first data by sending only the identification information of the format

reverse-conversion program, without sending the format reverse-conversion program.

An information processing method performed by, for example, a TC server of a transmission source according to a third aspect of the invention, includes the steps of: sending a request for sending a format reverse-conversion program for performing reverse conversion of format conversion, including designation of a destination of data, to a computer (for example, a RSP server in an embodiment) for performing the format conversion of data; and if the format reverse-conversion program is received from the computer for performing the format conversion of data, generating a digital signature for at least the format reverse-conversion program, and sending at least the generated digital signature, data, and the digital signature for the data to the computer for performing the format conversion of the data. The format reverse-conversion program may further be sent to the computer for performing the format conversion of the data.

By doing so, it becomes possible to confirm whether or not the format reverse-conversion program sent to a destination computer (for example, a TC server of a destination) is altered.

An information processing method performed by, for example, a TC server of a transmission source according to a fourth aspect of the invention, includes the steps of: sending a request for sending a format reverse-conversion program for performing reverse conversion of format conversion, including designation of a destination of data, to a computer for performing the format conversion of data; and if the format reverse-conversion program is received from the computer for performing the format conversion of data, generating a digital signature for at least the format reverse-conversion program and data, and sending at least the generated digital signature and the data to the computer for performing the format conversion of data. There is a case where the

digital signature is generated and sent in a different manner from the third aspect of the invention.

An information processing method performed by, for example, a TC server of a destination according to a fifth aspect of the invention, includes the steps of: receiving data for which format conversion for a destination has been performed, a digital signature for at least the data before the format conversion, and a format reverse-conversion program for performing reverse conversion of the format conversion; performing format reverse-conversion for the data for which the format conversion has been performed, by using the received format reverse-conversion program to generate reversely converted data; calculating a first hash value from at least the reversely converted data; restoring a second hash value from the received digital signature; and comparing the calculated first hash value with the restored second hash value to determine whether there is no alteration.

By doing so, it becomes possible to determine whether there is no alteration in the original data before processing by the RSP server and etc., even if the format conversion has been performed in the RSP server and etc. That is, it becomes possible to obtain verification of the transmission source.

Incidentally, there is a case where a second digital signature for the format reverse-conversion program is received in the receiving step and the fifth aspect of the invention further includes the steps of: calculating a third hash value from the format reverse-conversion program; restoring a fourth hash value from the second digital signature; and comparing the calculated third hash value with the restored fourth hash value to determine whether there is no alteration. It becomes possible to confirm that the format reverse-conversion program is certified by the transmission source and has no alteration, if the second digital signature for the format reverse-conversion program is received like this.

An information processing method performed by, for example, a TC server of a destination according to a sixth aspect of the invention, includes the steps of: receiving data for which format conversion for a destination has been performed, a digital signature 5 for at least the data before the format conversion, and identification information to identify a format reverse-conversion program for performing reverse conversion of the format conversion; extracting the format reverse-conversion program from a storage device by using the received identification information to identify the format 10 reverse-conversion program; performing the format reverse-conversion for the data for which the format conversion has been performed, by using the extracted format reverse-conversion program to generate a reversely converted data; calculating a first hash value from the reversely converted data; restoring a second hash 15 value from the received digital signature; and comparing the calculated first hash value with the restored second hash value to determine whether there is no alteration.

If the format reverse-conversion program is kept in the TC server of the destination, the format reverse-conversion program need 20 not be sent each time the data is sent, instead, only the identification information for identifying the format reverse-conversion program may be merely sent. However, if the country of the transmission source is known, a relevant format reverse-conversion program may be identified, so that an ID of the 25 format reverse-conversion program is not always necessary.

Incidentally, it is also possible to create a program for causing a computer to perform the information processing method according to the first to sixth aspects of the invention. The program may be stored in storage medium or storage device, such as a floppy 30 disk, a CD-ROM, a magneto-optical disk, a semiconductor memory, and a hard disk. Also, the program may be distributed via a network such as the Internet. Incidentally, the intermediate processed data is

temporarily stored in the computer memory.

#### BRIEF DESCRIPTION OF THE DRAWINGS

5 Fig. 1 is a drawing showing a system outline according to a first embodiment of the invention;

Fig. 2 is a drawing showing an example of a management table stored in a storage unit for format conversion and format reverse-conversion programs;

10 Fig. 3 a drawing showing a digital signature and an cryptographic method;

Fig. 4 a drawing showing an outline of a processing according to the first embodiment of the invention;

15 Fig. 5 is a flowchart illustrating a processing flow according to the first embodiment of the invention;

Fig. 6 is a drawing showing an outline of a processing according to a second embodiment of the invention;

Fig. 7 is a flowchart illustrating a processing flow according to the second embodiment of the invention;

20 Fig. 8 is a drawing showing a system outline according to a third embodiment of the invention;

Fig. 9 is a drawing showing an example of a management table stored in a format reverse-conversion program storage unit;

25 Fig. 10 is a drawing showing an outline of a processing according to the third embodiment of the invention; and

Fig. 11 is a flowchart illustrating a processing flow according to the third embodiment of the invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

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##### 1. First Embodiment

Fig. 1 schematically shows a system outline according to a first

embodiment of the invention. The first embodiment is a first example in a case where the invention is applied to a trading EDI (Electric Data Interchange) system. In this embodiment, it is assumed that document data need to be sent from a company A to a company B, and, 5 for example, the original document data having a format conforming to regulations of a country to which the company A belongs need to be converted to document data having a format conforming to regulations of a country to which the company B belongs.

The Internet 1 is a computer network, to which are connected 10 a TC server A (3) managed and operated by the company A, which is a transmission source of the document data such as an invoice, a RSP server 7 for providing, for example, a format conversion service of the document data and document data storage service, a TC server B (5) managed and operated by the company B, which is, for example, the 15 destination of the document data. Incidentally, more than two TC servers may be connected to the Internet 1. Also, there may be more than one RSP servers 7.

The TC server A (3) is connected to one or more user terminals 20 3b via, for example, LAN (Local Area Network) 3a. The TC server A (3) may be connected to the user terminal 3b via networks other than LAN, such as the Internet. An employee of the company A operates the user terminal 3b to instruct the TC server A (3) to send the document data. Similarly, the TC server B (5) is connected to one or more user terminals 5b via, for example, LAN 5a. The TC server 25 B (5) may be connected to the user terminal 5b via networks other than LAN, such as the Internet. An employee of the company B operates the user terminal 5b to instruct the TC server B (5) to receive the document data. Incidentally, the communication between the TC servers and the user terminals is encrypted by SSL (Secure Socket 30 Layer Protocol) method. In this embodiment, the explanation on the processing at the user terminals is omitted.

The RSP server 7 manages a storage unit 73 for format conversion

and format reverse-conversion programs, which stores format conversion programs to convert a format of the document data in accordance with the destination requirements upon a request from the transmission source, and a format reverse-conversion programs for 5 performing reverse conversion of the format conversion, and a document data storage unit 75 which stores the received document data and etc.

Fig. 2 shows an example of a management table for data stored in the storage unit 71 for format conversion and format 10 reverse-conversion programs. In the example of Fig. 2, it contains a column 201 of destination country names, a column 203 of format conversion program names, and a column 205 of format reverse-conversion program names. For example, in a case where the destination country name is the United States, the format conversion 15 program name is USA.exe, and the format reverse-conversion program name is USA\_iv.exe. In a case where the destination country name is Japan, the format conversion program name is JPN.exe, and the format reverse-conversion program name is JPN\_iv.exe. In a case where the destination country name is the United Kingdom, the format conversion 20 program name is UK.exe, and the format reverse-conversion program name is UK\_iv.exe. Such a management table is provided for each country of the transmission source. It should be noted that, in this example, the format conversion program and the format reverse-conversion program are provided for each country, but such 25 programs may be provided, not for each country, but for each zone or each company.

Next, a processing when data is encrypted and sent from one computer to another computer will be described first with reference to Fig. 3, then a processing flow of the system illustrated in Fig. 30 1 will be described. In a case where an original plain text data 311 is encrypted and sent from a transmission source computer 301 to a destination computer 303, the transmission source computer 301

performs a data encryption process 323 for the original plain text data 311 using a one-time common key 325 to generate an encrypted data 345. For the data encryption process 323, for example, the triple DES (Data Encryption Standard) may be used. Also, a hash algorithm 5 313 using, for example, a hash function SHA-1 is applied to the original plain text data 311 to generate an original hash value 319. Then, for example, a RSA encryption process 321 is applied to the original hash value 319 using a secret key 317 of the transmission source, to generate a digital signature 341. Also, a RSA encryption 10 process 327, for example, is applied to the one-time common key 325 using a destination's public key 331 obtained from a destination's public key certificate 329 to generate an encrypted one-time common key 347. The generated digital signature 341, the encrypted data 345, and the encrypted one-time common key 347 as well as the public key 15 certificate 315 of the transmission source are sent to the destination computer 303 according to HTTP (Hyper Text Transfer Protocol), for example.

When the destination computer 303 receives the digital signature 341 and the public key certificate 315 of the transmission source, it reads out the public key 355 of the transmission source 20 from the public key certificate 315 of the transmission source and performs a RSA decryption process 351 for the digital signature 341 to generate an original hash value 353. When the destination computer 303 receives the encrypted data 345 and the encrypted one-time common key 347, it performs a RSA decryption process 359 for the encrypted one-time common key 347 using a destination's secret key 363 to 25 restore the one-time common key 361. Then, it performs a data decryption process 357 for the encrypted data 345 using the restored one-time common key 361 to generate received plain text data 367. 30 Incidentally, the destination computer 303 keeps the destination's public key certificate 329, it will be sent to the transmission source, if necessary. The same hash algorithm 369 as one used in the

transmission source is applied to the received plain text data 367, to generate a hash value 371. Then, the original hash value 353 and the generated hash value 371 are compared as by a comparison process 373 to verify whether the received plain text data 367 has no 5 alteration from the original plain text 311. Namely, if the original hash value 353 and the generated hash value 371 coincide with each other, there is no alteration. On the other hand, the two values do not coincide with each other, the alternation may possibly occur. If there is no alteration, the received plain text data 367 can be used 10 for the later process.

Based on the above-described processes, the outline of the processes according to the first embodiment of the invention will be described with reference to the Fig. 4. The TC server A (3) as a transmission source computer generates document data A (401) such as 15 an invoice, and generates a digital signature 403 by the company A for the document data A (401). Then, the document data A (401) and the digital signature 403 by the company A are sent to the RSP server 7. At this time, the processes illustrated in Fig. 3 are performed. That is, the digital signature 403 by the company A is generated by 20 calculating a hash value of the document data A (401) and encrypting the generated hash value using the secret key of the company A. And, the document data A (401) is encrypted using the one-time common key, and the one-time common key is also encrypted using the public key of the RSP. Then, the encrypted document data A (401), the encrypted 25 one-time common key, the public key certificate for the company A, and the digital signature by the company A are sent to the RSP server 7.

The RSP server 7 performs the processes illustrated in Fig. 3 at reception. Namely, the RSP server 7 reads out the public key 30 of the company A from the public key certificate of the company A, and performs a RSA decryption process for the digital signature by the company A using the public key of the company A to restore the

original hash value. Also, the RSP server 7 decrypts the encrypted one-time common key using the secret key of the RSP to obtain the one-time common key, and then decrypts the encrypted document data A (401) using the one-time common key. The RSP server 7 applies the 5 hash algorithm to the decrypted document data A (401) to calculate a hash value, and then compares it with the original hash value to verify whether there is no alteration.

After that, the RSP server 7 performs the format conversion in accordance with requirements of the destination of the document 10 data A (401) using the format conversion program to generate a format-converted document data A (405). Also, the RSP server 7 reads out a format reverse-conversion program 407 for performing reverse conversion of the format conversion from the storage unit 71 for format conversion and format reverse-conversion programs. Then, the 15 RSP server 7 generates a digital signature 409 by the RSP for the format-converted document data A (405), the format reverse-conversion program 407, and the digital signature 403 by the company A. That is, the RSP server 7 calculates a hash value from the format-converted document data A (405), the format 20 reverse-conversion program 407, and the digital signature 403 by the company A, and then encrypts the calculated hash value using the secret key of the RSP. The RSP server 7 sends the format-converted document data A (405), the format reverse-conversion program 407, the digital signature 403 by the company A and the digital signature 409 25 by the RSP to the TC server B (5).

At this sending step, the processes illustrated in Fig. 3 are performed. Namely, the format-converted document data A (405), the format reverse-conversion program 407, and the digital signature 403 by the company A as the original plain data are encrypted using the 30 one-time common key, and the encrypted data together with the digital signature 409 by the RSP, the public key certificate of the RSP, and the one-time common key encrypted using the public key of the company

B are sent to the TC server B (5). Incidentally, in this embodiment, the public key certificate of the company A may have to be sent to the TC server B (5). But, if the public key certificate of the company A can be obtained otherwise, it needs not be sent.

5 The TC server B (5) performs the processes illustrated in Fig. 3 at reception. Namely, the TC server B (5) reads out the public key of the RSP from the public key certificate of the RSP to perform the RSA decryption process for the digital signature 409 by the RSP, and restores the original hash value. Also, the TC server B (5) decrypts  
10 the encrypted one-time common key using the secret key of the company B to obtain the one-time common key, and then decrypts the encrypted data 403 to 407 using the one-time common key. The TC server B (5) calculates a hash value by applying the hash algorithm to the decrypted data 403 to 407, and compares the calculated hash value with  
15 the original hash value to verify whether there is no alteration.

If it is confirmed that there is no alteration, the TC server B (5) performs the format reverse-conversion for the format-converted document data A (405) using the format reverse-conversion program 407, to generate a document data A (411). Also, the TC server B (5) applies  
20 the hash algorithm to the document data A (411) to calculate a hash value 413. When the server B (5) reads out the public key of the company A from the public key certificate of the company A and decrypts the digital signature 403 by the company A using the public key of the company A, an original hash value 415 is restored. Therefore,  
25 by comparing the hash value 413 with the original hash value 415, the format-converted document data A (405) can be verified whether it is generated from the authentic document data A (401).

The aforementioned processes are summarized in Fig. 5. The TC server A (3) generates document data such as an invoice, generates  
30 the digital signature by the company A for the document data, and then sends the digital signature by the company A, the document data, and designation information of the destination to the RSP server 7 (step

S1). As mentioned above, the encryption is performed for the document data as shown in Fig. 3, and the encrypted document data, the public key certificate of the company A, and the encrypted one-time common key are sent to the RSP server 7. The RSP server 7 receives the digital 5 signature by the company A, the document data, and the designation of the destination from the TC server A (3) (step S3). At reception, the RSP server 7 decrypts the document data and verifies whether there is no alteration in the received document data as shown in Fig. 3. When it is confirmed that there is no alteration, the RSP server 7 10 stores the document data in the document data storage unit 75.

The RSP server 7 reads out the format conversion program for performing the format conversion according to the requirements of the destination, from the storage unit 71 for format conversion and format reverse-conversion programs. By performing the format conversion for 15 the document data using the read format conversion program, it generates a format-converted document data and stores the generated data into the document data storage unit 75, for example (step S5). Then, the RSP server 7 reads out the format reverse-conversion program for performing the reverse conversion of the performed format 20 conversion from the storage unit 71 for format conversion and format reverse-conversion programs, and generates a digital signature by the RSP for the format reverse-conversion program, the format-converted document data, and the digital signature by the company A. As described with reference to the Figs. 3 and 4, the RSP server 7 25 calculates a hash value from the format reverse-conversion program, the format-converted document data and the digital signature by the company A, and encrypts the calculated hash value using the secret key of the RSP. Then, the RSP server 7 sends the format reverse-conversion program, the format-converted document data, the 30 digital signature by the company A, and the digital signature by the RSP to the TC server B (5) (step S7). At sending step, as shown in Fig. 3, the RSP server 7 encrypts the format reverse-conversion

program, the format-converted document data and the digital signature by the company A, and sends the encrypted data and the digital signature by the RSP as well as the public key certificate of the RSP and the encrypted one-time common key. Further, the public key 5 certificate of the company A may be sent as well.

The TC server B (5) receives the format reverse-conversion program, the format-converted document data, the digital signature by the company A, and the digital signature by the RSP from the RSP server 7 (step S9). At reception, as shown in Fig. 3, the TC server 10 B (5) decrypts the received data and verifies whether there is no alteration in the received data. If it is confirmed that there is no alteration, the TC server B (5) performs the format reverse-conversion for the document data using the format reverse-conversion program to restore the document data (step S11). 15 The restored document data is stored in a memory, for example. However, it is not yet verified whether this restored document data is identical with the data generated in the TC server A (3). Thus, the TC server B (5) generates a hash value from the restored document data (step S13). And, the TC server B (5) decrypts the digital signature 20 by the company A using the public key of the company A to generate the hash value (step S15). Then, the TC server 5 compares the hash value generated in the step S13 with the hash value decrypted in the step S15 to determine whether they coincide with each other (step S17). If they coincide with each other, the restored document data is the 25 authentic document data generated by the company A, and the format-converted document data can be used as the authentic document data (step S19). The document data is stored in a storage unit. On the other hand, if they do not coincide with each other, the restored document data cannot be regarded as the document data generated by 30 the company A and converted using the conversion program approved by the company A, and a warning is issued to the user terminal 5b, for example (step S21).

By doing so, the received document data can be verified as the authentic document data originated by the transmission source, even if the RSP server 7 performs the format conversion.

5 2. Second Embodiment

In the first embodiment, the RSP server 7 itself has the format reverse-conversion program, and sends it to the TC server B (5) as the destination. On the other hand, the company A as the transmission source generates the digital signature for the document data. In 10 other words, the company B obtains the conclusive evidence for the document data from the company A as the transmission source. But, for the format reverse-conversion program, the company B obtains the conclusive evidence only from the RSP server 7. In some cases, however, it is better to obtain the conclusive evidence from the company A for 15 the format reverse-conversion program, too. This second embodiment of the invention presents an example in a case where the destination company B can obtain the conclusive evidence for the format reverse-conversion program from the company A as the transmission source.

20 Incidentally, the second embodiment of the invention has the same system configuration as that shown in Fig. 1. And, to explain as the second embodiment, the TC server A (3) changes its name to a TC server E (3E), and the TC server B (5) changes its name to a TC server F (5F).

25 First of all, the outline of the processing will be described with reference to Fig. 6. First, the TC server E (3E) as the transmission source computer obtains a format reverse-conversion program 605 corresponding to the destination from the RSP server 7. At this time, the processes shown in Fig. 3 are performed. Namely, 30 the RSP server 7 encrypts the format reverse-conversion program 605 using a one-time common key, and encrypts the one-time common key using a public key of the company E. The RSP server 7 calculates a

hash value of the format reverse-conversion program 605 using a predefined hash algorithm, and generates a digital signature by encrypting the calculated hash value using the secret key of the RSP. Then, the RSP server 7 sends the encrypted format reverse-conversion program 605, the public key certificate of the RSP, the encrypted one-time common key, and the digital signature to the TC server E (3E). The TC server E (3E) receives the encrypted format reverse-conversion program 605, the public key certificate of the RSP, the encrypted one-time common key and the digital signature, and decrypts the one-time common key using a secret key of the company E. Then, the TC server E (3E) decrypts the format reverse-conversion program 605 using the one-time common key. Also, the TC server E (3E) obtains a public key of the RSP from the public key certificate of the RSP, and decrypts the digital signature by the RSP to restore the original hash value. On the other hand, the TC server E (3E) calculates a hash value by applying the predefined hash algorithm to the format reverse-conversion program 605 to calculate a hash value. By comparing the restored hash value with the calculated hash value, the TC server E (3E) determines whether there is no alteration.

If it is confirmed that there is no alteration, the TC server E (3E) generates a second digital signature 607 by the company E for the format reverse-conversion program 605. Namely, the TC server E (3E) applies a predefined hash algorithm to the format reverse-conversion program 605 to calculate a hash value, and encrypts the calculated hash value using the secret key of the company E. Further, the TC server E (3E) generates a document data B (601) such as an invoice and a second digital signature 603 by the company E for the document data B (601). That is, the TC server E (3E) calculates a hash value from the document data B (601) according to the predefined hash algorithm, and encrypts the calculated hash value using the secret key of the company E.

Then, the TC server E (3E) sends the document data B (601),

the first digital signature 603 by the company E, the format reverse-conversion program 605, and the second digital signature 607 by the company E to the RSP server 7. At this time, the processes as shown in Fig. 3 are performed. Namely, the TC server E (3E) 5 generates the first digital signature 603 by the company E by calculating a hash value of the document data B (601) and encrypting the calculated hash value using the secret key of the company E. The document data B (601) is also encrypted using the one-time common key, and the one-time common key is encrypted using the public key of the 10 RSP. Further, the TC server E (3E) generates the second digital signature 607 by the company E by calculating a hash value of the format reverse-conversion program 605 and encrypting the calculated hash value using the secret key of the company E. In addition, the format reverse-conversion program 605 is encrypted using the one-time 15 common key. Then, the encrypted document data B (601), the encrypted one-time common key, the public key certificate of the company E, the encrypted format reverse-conversion program 605, the first digital signature 603 by the company E and the second digital signature 607 by the company E are sent to the RSP server 7.

20 The RSP server 7 performs the processes as shown in Fig. 3 at reception. That is, the RSP server 7 obtains the public key of the company E from the public key certificate of the company E, and performs the RSP decryption process for the first digital signature 603 by the company E to restore an original hash value  $\alpha_1$ . Also, the 25 RSP server 7 decrypts the encrypted one-time common key using the secret key of the RSP to obtain the one-time common key, and decrypts the encrypted document data B (601) using the one-time common key. The RSP server 7 calculates a hash value  $\beta_1$  by applying a hash algorithm to the decrypted document data B (601), and compares the calculated 30 hash value  $\beta_1$  with the original hash value  $\alpha_1$  to verify whether there is no alteration. Similarly, the RSP server 7 obtains the public key of the company E, and performs the RSA decryption process for the

second digital signature 605 by the company E to restore an original hash value  $\alpha_2$ . Also, the RSP server 7 decrypts the encrypted format reverse-conversion program 605 using the one-time common key. The RSP server 7 calculates a hash value  $\beta_2$  by applying the predefined hash algorithm to the format reverse-conversion program 605, and compares the calculated hash value  $\beta_2$  with the original hash value  $\alpha_2$  to verify whether there is no alteration.

After that, the RSP server 7 performs the format conversion according to requirements of the destination of the document data B (601) using the format conversion program to generate a format-converted document data B (609). The RSP server 7 also generates a digital signature 611 by the RSP for the format-converted document data B (609), the format reverse-conversion program 605, the second digital signature 607 by the company E, and the first digital signature 603 by the company E. That is, the RSP server 7 calculates a hash value from the format-converted document data B (609), the format reverse-conversion program 605, the second digital signature 607 by the company E and the first digital signature 603 by the company E, and encrypts the calculated hash values using the secret key of the RSP. The RSP server 7 sends the format-converted document data B (609), the format reverse-conversion program 605, the second digital signature 607 by the company E, the first digital signature 603 by the company E, and the digital signature 611 by the RSP to the TC server F (5F).

At this sending step, the processes as shown in Fig. 3 are performed. Namely, the format-converted document data B (609), the format reverse-conversion program 605, the second digital signature 607 by the company E, the first digital signature 603 by the company E, as plain text data, are encrypted using the one-time common key, and the encrypted data, the digital signature 611 by the RSP, the public key certificate of the RSP, and the one-time common key encrypted using the public key of the company F are sent to the TC

server F (5F). Incidentally, in this embodiment, the public key certificate of the company E may have to be sent to the TC server F (5F). However, if the public key certificate of the company E can be obtained otherwise, it need not be sent.

5 The TC server F (5F) performs the processes as shown in Fig. 3 at reception. Namely, the TC server F (5F) obtains the public key of the RSP from the public key certificate of the RSP, and performs the RSA decryption process for the digital signature 611 by the RSP using the public key of the RSP to restore the original hash value.  
10 Also, the TC server F (5F) decrypts the encrypted one-time common key using the secret key of the company F to obtain the one-time common key and decrypts the encrypted data 603 to 609 using the one-time common key. The TC server F (5F) applies a predefined hash algorithm to the decrypted data 603 to 609 to calculate a hash value. Then,  
15 the TC server F (5F) compares the calculated hash vale with the original hash value to verify whether there is no alteration.

If it is confirmed that there is no alteration, the TC server F (5F) calculates a hash value 613 by applying the predefined hash algorithm to the format reverse-conversion program 605, and decrypts  
20 the second digital signature 607 by the company E using the public key of the company E to restore the original hash value 615. Then, it compares the calculated hash value 613 with the original hash value 615 to verify whether the format reverse-conversion program 605 is one approved by the company E.

25 If it is confirmed that the format reverse-conversion program 605 is one approved by the company E, the TC server F (5F) generates document data B (617) by applying the format reverse-conversion program 605 to the format-converted document data 609. Then, the TC server F (5F) generates a hash value 619 from the document data B (617)  
30 by the predefined hash algorithm. On the other hand, the TC server F (5F) reads out the public key of the company E from the public key certificate of the company E and decrypts the first digital signature

603 by the company E using the public key of the company E to restore the original hash value 621. Then, the TC server F (5F) compares the hash value 619 with the hash value 621, to determine if the format-converted document data 609 is one generated from the 5 authentic document data B (601), i.e., the data 609 is the document data generated by the company E and format-converted by the conversion program approved by the company E.

Next, the processing flow of the second embodiment of the invention will be described with reference to the Fig. 7. First, the 10 TC server E (3E) sends a request for sending a format reverse-conversion program, including designation of the destination (step S31). The designation of the destination may be specified by the destination itself, or the destination's group, such as destination country. When the RSP server 7 receives the request for 15 sending the format reverse-conversion program, including the designation of the destination, from the TC sever E (3E) (step S33), it extracts the format reverse-conversion program corresponding to the destination from the storage unit 71 for format conversion and format reverse-conversion programs and sends it to the TC server E 20 (3E) (step S35). Incidentally, the format reverse-conversion program may be specified by both of the transmission source and the destination. In such a case, the format reverse-conversion program corresponding to both of the transmission source and the destination is read out from the storage unit 71 for format conversion and format 25 reverse-conversion programs. As shown in Fig. 3, the format reverse-conversion program is encrypted, and then the encrypted format reverse-conversion program is sent together with the digital signature by the RSP, the public key certificate of the RSP, and the encrypted one-time public key and etc.

30 The TC server E (3E) receives the format reverse-conversion program corresponding to the destination from the RSP server 7 (step S37). As shown in Fig. 3, the TC server E (3E) decrypts the one-time

common key, and decrypts the format reverse-conversion program using the decrypted one-time common key. Furthermore, the TC server E (3E) calculates a hash value from the format reverse-conversion program, restores the original hash value from the digital signature by the RSP, and compares the calculated hash value with the original hash value to verify whether there is no alteration. Then, if it is confirmed that there is no alteration, the TC server E (3E) generates a first digital signature by the company E for the document data, and generates a second digital signature by the company E for the format reverse-conversion program. Then, the TC server E (3E) sends the document data, the first digital signature by the company E for the document data, the format reverse-conversion program, and the second digital signature by the company E for the format reverse-conversion program to the RSP server 7 (step S39). At this time, the destination information may be sent again. Also here, the processes as shown in Fig. 3 are performed. The TC server E (3E) calculates a hash value by applying the predefined hash algorithm to the document data and encrypts the calculated hash value using the secret key of the company E to generate the first digital signature by the company E. The TC server E (3E) also applies the predefined hash algorithm to the format reverse-conversion program to calculate a hash value, and encrypts the calculated hash value using the secret key of the company E to generate a second digital signature by the company E. The TC server E (3E) encrypts the document data and the format reverse-conversion program using the one-time common key, and then encrypts the one-time common key using the public key of the RSP. Then, the TC server E (3E) sends the encrypted document data, the encrypted format reverse-conversion program, the encrypted one-time common key, and the first and second digital signatures as well as the public key certificate of the company E to the RSP server 7.

The RSP server 7 receives the first digital signature by the company E, the document data, the second digital signature by the

company E, and the format reverse-conversion program from the TC server E (3E) (step S41). At reception, the RSP server 7 decrypts the document data, and verifies whether there is no alteration in the received document data, as shown in Fig. 3. If it is confirmed that 5 there is no alteration, the document data is stored in the document data storage unit 75. Also, the RSP server 7 decrypts the encrypted format reverse-conversion program, and verifies whether there is no alteration in the received format reverse-conversion program.

Then, the RSP server 7 reads out the format conversion program 10 corresponding to the destination from the storage unit 71 for format conversion and format reverse-conversion programs to perform the format conversion. Then, the RSP server 7 uses the read format conversion program to perform the format conversion for the document data to generate a format-converted document data, and stores it in 15 the document data storage unit 75, for example (step S43). Then, the RSP sever 7 generates a digital signature by the RSP for the received format reverse-conversion program, the second digital signature by the company E, the format-converted document data, and the first digital signature by the company E. As described with reference to 20 Figs. 3 and 6, the RSP server 7 calculates a hash value from the format reverse-conversion program, the second digital signature by the company E, the format-converted document data, and the first digital signature by the company E, and encrypts the calculated hash value using the secret key of the RSP. Then, the RSP server 7 sends the 25 format reverse-conversion program, the second digital signature by the company E, the format-converted document data, the first digital signature by the company E, and the digital signature by the RSP to the TC server F (5F) (step S45). At sending, the RSP server 7 encrypts the format reverse-conversion program, the second digital signature 30 by the company E, the format-converted document data and the first digital signature by the company E, and sends them together with the public key certificate of the RSP and the encrypted one-time common

key, as shown in Fig. 3. Incidentally, the public key certificate of the company E may be sent.

The TC server F (5F) receives the format reverse-conversion program, the second digital signature by the company E, the 5 format-converted document data, the first digital signature by the company E and the digital signature by the RSP from the RSP server 7 (step S47). At reception, the TC server F (5F) decrypts the received data and verifies whether there is no alteration in the received data, as shown in Fig. 3. If it is confirmed that there is no alteration, 10 the TC server F (5F) applies the predefined hash algorithm to the format reverse-conversion program to generate a hash value, and decrypts the second digital signature by the company E using the public key of the RSP to generate the decrypted hash value (step S49). Next, the TC server F (5F) compares the generated hash value with the 15 decrypted hash value to verify whether the format reverse-conversion program is one contemplated by the transmission source (step S51). If the generated hash value and the decrypted hash value do not coincide with each other, the format reverse-conversion program is not one contemplated by the transmission source. Therefore, the 20 process proceeds to step S63, and a warning to the effect that the format reverse-conversion program is not approved by the company E is issued.

On the other hand, if it is determined that the generated hash value and the decrypted hash value coincide with each other in the 25 step S51, the TC server F (5F) uses the format reverse-conversion program to perform the format reverse-conversion for the received format-converted document data to restore the document data (step S53). The restored document data is stored in a memory, for example. However, it is not yet verified whether this restored document data 30 is the same as the data generated by the TC server E (3E). Then, the TC server F (5F) generates a second hash value from the restored document data (step S55). Also, it decrypts the first digital

signature by the company E using the public key of the company E to generate the decrypted second hash value (step S57). The TC server F (5F) compares the second hash value generated in the step S55 with the second hash value decrypted in the step S57 to determine if they 5 coincide with each other (step S59). If they coincide with each other, the document data is the authentic document data by the company E, thus, the format-converted document data can be used as the authentic document (step S61). The document data is stored in a storage unit. However, if they do not coincide with each other, the received data 10 cannot be regarded as the document data generated by the company E and format-converted by the conversion program approved by the company E. Therefore, a warning is issued to the user terminal 5b, for example (step S63).

As described above, it becomes possible to verify whether the 15 received document data is the authentic document data originated by the transmission source even if the RSP server 7 performs the format conversion. Also, it can be verified whether the format reverse-conversion program to be executed in the TC server F (5F) is the format reverse-conversion program contemplated by the 20 transmission source, therefore it can be reliably executed by the TC server F (5F).

In some cases, the format reverse-conversion program may not be sent from the TC server E (3E) to the RSP server 7 in the step S39. Also, though the digital signatures by the company E are separately 25 generated for each of the format reverse-conversion program and the document data, one digital signature by the company E may be generated collectively.

### 3. Third Embodiment

30 In the first and second embodiments of the invention, the format reverse-conversion program is sent from the RSP server to the TC server of the destination. However, if the destination keeps a set

of the format reverse-conversion programs and can specify the format reverse-conversion program to be executed at the destination, the format reverse-conversion program need not be sent each time the document data is sent. In the third embodiment of the invention, an 5 example in a case where the destination keeps the set of the format reverse-conversion programs will be described.

Fig. 8 shows a drawing of a system outline according to the third embodiment of the invention. A TC server C (13) managed and operated by a company C which is a transmission source of the document 10 data such as an invoice, a RSP server 17 for providing a format conversion service of document data and a document data storage service, a TC server D (15) managed and operated by a company D which is a destination of the document data are connected to the Internet 11, which is a computer network. Not only two, but also a lot of TC 15 servers are connected to the Internet 11. Also, not only one, but also a plurality of RSP servers 17 may be provided.

The TC server C (13) is connected to one or a plurality of user terminals 13b via, for example, LAN (Local Area Network) 13a. Incidentally, the TC server C (13) may be connected to the user 20 terminal 13b via networks other than LAN, such as the Internet. An employee of the company C operates the user terminal 13b to instruct the TC server C (13) to send the document data. In addition, the TC server C (13) manages a storage unit 13c for storing format reverse-conversion programs. Similarly, the TC server D (15) is 25 connected to one or a plurality of user terminals 15b via, for example, LAN 15a. Incidentally, the TC server B (15) may be connected to the user terminal 15b via networks other than LAN, such as the Internet. An employee of the company D operates the user terminal 15b to instruct 30 the TC server D (15) to receive the document data. In addition, the TC server D (15) manages a storage unit 15c for format reverse-conversion programs. In this embodiment, the explanation on the processing at the user terminals is omitted.

The RSP server 17 manages a format conversion program storage unit 171, which stores the format conversion programs for performing format conversion of document data upon a request from a transmission source according to a destination, and a document data storage unit 5 175, which stores the received document data and etc.

Fig. 9 shows an example of a management table of data stored in the storage unit 13c and 15c for format reverse-conversion programs. In the example of Fig. 9, the management table includes a column 901 of a format reverse-conversion program ID and a column 903 of a format 10 reverse-conversion program name. For example, in a case where the country name of the transmission source is the United States, the ID of the format reverse-conversion program is USA, and the name of the format reverse-conversion program corresponding to the ID is USA\_iv.exe. In a case where the country name of the transmission 15 source is Japan, the ID of the format reverse-conversion program is JPN, and the name of the format reverse-conversion program is JPN\_iv.exe. In a case where the country name of the transmission source is the United Kingdom, the ID of the format reverse-conversion program is UK, and the name of the format reverse-conversion program 20 is UK\_iv.exe. It should be noted that, in this example, the format reverse-conversion program is provided for each country, but it may be provided for each zone or each company.

Incidentally, in the format conversion program storage unit 171, a management table is provided, which stores the names of the 25 format conversion programs correspondingly to the destination country name. The management table is provided for each country of the transmission source, and the ID of the format reverse-conversion program is stored correspondingly to the management table. Incidentally, the management table may not be provided for each 30 country, but for each zone or each company.

Next, the processing outline of the third embodiment of the invention will be described with reference to Fig. 10. The TC server

C (13) as a transmission source computer generates document data C (1001) such as an invoice, and a digital signature 1003 by the company C for the document data C (1001). Then, the TC server C (13) sends the document data C (1001) and the digital signature 1003 by the 5 company C to the RSP server 17. At this time, the processes as shown in Fig.3 are performed. That is, the TC server C (13) calculates a hash value of the document data C (1001) and encrypts the calculated hash value using a secret key of the company C to generate the digital signature 1003 by the company C. Also, the document data C (1001) 10 is encrypted using a one-time common key, and the one-time common key is also encrypted using a public key of the RSP. Then, the TC server C (13) sends the encrypted document data C (1001), the encrypted one-time common key, a public key certificate of the company C, the digital signature 1003 by the company C to the RSP server 17.

15 The RSP server 17 performs the processes as shown in Fig. 3 at reception. The RSP server 17 obtains the public key of the company C from the public key certificate of the company C, and performs the RSA decryption process for the digital signature 1003 by the company C to restore the original hash value. Also, the RSP server 17 decrypts 20 the encrypted one-time common key using the secret key of the RSP to obtain the one-time common key and decrypts the encrypted document data C (1001) using the one-time common key. The RSP server 17 calculates a hash value by applying the predefined hash algorithm to the decrypted document data C (1001). Then, the RSP server 17 compares 25 the calculated hash value with the original hash value to verify whether there is no alteration.

After that, the RSP server 17 performs the format conversion by the format conversion program according to the destination of the document data C (1001), to generate format-converted document data 30 C (1005). Then, the RSP server 17 generates a digital signature 1009 by the RSP for the format-converted document data C (1005), a format reverse-conversion program ID 1007 and the digital signature 1003 by

the company C. That is, the RSP server 17 calculates a hash value from the format-converted document data C (1005), the format reverse-conversion program ID 1007 and the digital signature 1003 by the company C, and then encrypts the calculated hash value using the 5 secret key of the RSP. The RSP server 17 sends the format-converted document data C (1005), the format reverse-conversion program ID 1007, the digital signature 1003 by the company C, the digital signature 1009 by the RSP to the TC server D (15).

Incidentally, the digital signature by the RSP may not be 10 generated for the format reverse-conversion program ID 1007 as shown in (b) in Fig. 10. That is, in a case where information of the transmission source (e.g., the country name, the company identifier, or the address in the network on the transmission source) is used as a format reverse-conversion program ID, the digital signature by the 15 RSP may not need be generated for the format reverse-conversion program ID 1007. In such a case, the format conversion according to the destination of the document data C (1001) is performed by the format conversion program to generate the format-converted document data C (1005). Also, the RSP server 17 reads out the format 20 reverse-conversion program ID 1007 from the format conversion program storage unit 171. Then, the RSP server 17 generates the digital signature 1011 by the RSP for the format-converted document data C (1005) and the digital signature 1003 by the company C. That is, the RSP server 17 calculates a hash value from the format-converted 25 document data C (1005) and the digital signature 1003 by the company C, and encrypts the calculated hash value using the secret key of the RSP. The RSP server 17 sends the format-converted document data C (1005), the digital signature 1003 by the company C, the digital signature 1011 by the RSP, and the format reverse-conversion program 30 ID 1007 to the TC server D (15).

At this sending, the processes as shown in Fig. 3 are performed. In the first example (a) shown in Fig. 10, the format-converted

document data C (1005), the format reverse-conversion program ID 1007, and the digital signature 1003 by the company C as original plain text data are encrypted using a one-time common key. The encrypted data, the digital signature 1009 by the RSP, the public key certificate of 5 the RSP, and the one-time common key encrypted using the public key of the company D are sent to the TC server D (15). Incidentally, in this embodiment, the public key certificate of the company C may have to be sent to the TC server D (15). However, in a case where the public key certificate of the company C can be obtained by other means, it 10 need not be sent.

In the second example (b) shown in Fig. 10, the format-converted document data C (1005), the digital signature 1003 by the company C as original plain text data are encrypted using a one-time common key, and the encrypted data, a format reverse-conversion program ID 1007, 15 the digital signature 1011 by the RSP, the public key certificate of the RSP, and the one-time common key encrypted by the public key of the company D are sent to the TC server D (15).

The TC server D (15) performs the processes as shown in Fig. 3 at reception. Namely, the TC server D (15) obtains the public key 20 of the RSP from the public key certificate of the RSP, and performs the RSA decryption process for the digital signature 1009 by the RSP to restore the original hash value. Also, the TC server D (15) decrypts the encrypted one-time common key using the secret key of the company D to obtain the one-time common key, and decrypts the 25 encrypted data 1003 to 1007 using the one-time common key. The TC server D (15) applies the hash algorithm to the decrypted data 1003 to 1007 to calculate the hash value. The TC server D (15) compares the calculated hash value with the original hash value to verify whether there is no alteration. In the second example (b) shown in 30 Fig. 10, the TC server D (15) obtains the public key of the RSP from the public key certificate of the RSP, and performs the RSA decryption process for the digital signature 1011 by the RSP to restore the

original hash value. Also, the TC server D (15) obtains the one-time common key by decrypting the encrypted one-time common key using the secret key of the company D, and decrypts the encrypted data 1003 and 1005 using the one-time common key. The TC server D (15) calculates 5 a hash value by applying the predefined hash algorithm to the decrypted data 1003 and 1005. Then, the TC server D (15) compares the calculated hash value with the original hash value to verify whether there is no alteration.

If it is confirmed that there is no alteration, the TC server 10 D (15) uses the format reverse-conversion program ID 1007 to extract the corresponding format reverse-conversion program from the storage unit 15c for format reverse-conversion programs. The TC server D (15) performs the format reverse-conversion for the format-converted document data C (1005) using the extracted format reverse-conversion 15 program to generate document data C (1013). Also, it applies the predefined hash algorithm to the document data C (1013) to calculate a hash value 1017. On the other hand, the TC server D (15) reads out the public key of the company C from the public key certificate of the company C, and decrypts the digital signature 1003 by the company 20 C using the public key of the company C to restore the original hash value 1015. Therefore, by comparing the hash value 1017 with the hash value 1015, the TC server D (15) can verify whether the format-converted document data C (1005) is one generated from the authentic document data C (1001).

25 The aforementioned processing is summarized in Fig. 11. The TC server C (13) generates the document data such as an invoice, generates the digital signature by the company C for the document data, and sends the digital signature by the company C, the document data, and designation of the destination to the RSP server 17 (step S71). 30 Incidentally, the information (e.g., identification information) on the transmission source is also sent. As shown in Fig. 3, the data is encrypted and sent together with the public key certificate of the

company C and the encrypted one-time common key. The RSP server 17 receives the digital signature by the company C, the document data, and designation of the destination from the TC server C (13) (step S73). It also receives information on the transmission source. At 5 reception, as shown in Fig. 3, the RSP server 17 decrypts the document data, and verifies whether there is no alteration in the received document data. If it is confirmed that there is no alteration, the RSP server 17 stores the document data in the document data storage unit 175.

10 In addition, the RSP server 17 reads out the format conversion program for performing the format conversion according to the destination requirements, from the format conversion program storage unit 171. Then, the RSP server 17 performs the format conversion for the document data using the format conversion program to generate the 15 format-converted document data, and stores it in the document data storage unit 175, for example (step S75). Then, the RSP server 17 reads the format reverse-conversion program ID for the reverse conversion of the performed format conversion from the format conversion program storage unit 171 based on, for example, the 20 information on the transmission source. The RSP server 17 generates a digital signature by the RSP for the format reverse-conversion program ID, the format-converted document data and the digital signature by the company C. As described, the digital signature by the RSP may be generated for the format-converted document data and 25 the digital signature by the company C. As described with reference to Figs. 3 and 10, the RSP server 17 calculates a hash value from the format reverse-conversion program ID, the format-converted document data and the digital signature by the company C, and encrypts the calculated hash value using the secret key of the RSP. Also, the RSP 30 server 17 may calculate a hash value from the format-converted document data and the digital signature by the company C, and encrypt the calculated hash value using the secret key of the RSP. Then, the

RSP server 17 sends the format reverse-conversion program ID, the format-converted document data, the digital signature by the company C, and the digital signature by the RSP to the TC server D (15) (step S77). At sending, as shown in Fig. 3, the format reverse-conversion program ID, the format-converted document data, and the digital signature by the company C are encrypted, and sent together with the public key certificate of the RSP and the encrypted one-time common key. As described, the format reverse-conversion program ID may be sent without encryption. Incidentally, the public key certificate of the company C may be sent as well.

The TC server D (15) receives the format reverse-conversion program ID, the format-converted document data, the digital signature by the company C, and the digital signature by the RSP from the RSP server 17 (step S79). At reception, as shown in Fig. 3, the TC server D (15) decrypts the received data and verifies whether the received data is not altered. If it is confirmed that there is no alteration, the TC server D (15) uses the format reverse-conversion program ID to read out the corresponding format reverse-conversion program from the storage unit 15c for format reverse-conversion programs. Then, the TC server D (15) performs the format reverse-conversion for the format-converted document data to restore the document data with the original format (step S81). The restored data is stored in a memory. However, it is not verified yet if the restored document data is the same as the data generated in the TC server C (13). Then, the TC server D (15) generates a hash value from the restored document data (step S83). Also, the TC server D (15) decrypts the digital signature by the company C using the public key of the company C to generate the decrypted hash value (step S85). Then, the TC server D (15) compares the hash value generated in the step S83 with the hash value decrypted in the step S85 to determine whether they coincide with each other (step S87). If they coincide with each other, the document data is the authentic document data by the company C, thus, the

format-converted document data can be used as authentic document data (step S89). The document data is stored in a storage unit, for example. On the other hand, if they do not coincide with each other, the document data is not regarded as data generated by the company C and 5 converted by the conversion program approved by the company C, and a warning is issued to the user terminal 15b, for example (step S91).

Thus, the document data can be verified as the authentic document data originated by the transmission source, even if the format conversion is performed by the RSP server 17.

10 While the embodiments of the invention have been described, the invention is limited to the aforementioned embodiments. For example, the names such as a TC server or a RSP server are only examples, and computers with other names but with the same functions can be employed as well. Also, the TC server and/or RSP server may not be 15 implemented with a single computer, but a plurality of computers. Also, in the above embodiments, RSA is used for the public key cryptographic method, but other encryption methods including ElGamal cryptosystem, elliptic curve cryptosystem, and hyper-elliptic curve cryptosystem may be employed. The common key cryptographic method 20 is not limited to DES. The example is given as to the format conversion, but other conversions shall be included.

Although the present invention has been described with respect to a specific preferred embodiment thereof, various change and modifications may be suggested to one skilled in the art, and it is 25 intended that the present invention encompass such changes and modifications as fall within the scope of the appended claims.